TRANSIMS TRAVELOGUE

June 1995

TRANSIMS TRAVELOGUE describes current activities within the TRANSIMS project.

(LAUR-95-2035)

WHAT IS TRANSIMS?

The TRansportation ANalysis and SIMulation System (TRANSIMS) is one part of the multi-track Travel Model Improvement Program sponsored by the U.S. Department of Transportation, the Environmental Protection Agency, and the Department of Energy. The TRANSIMS project has been identified as a major effort to develop new, integrated transportation and air quality forecasting procedures necessary to satisfy the Intermodal Surface Transportation Efficiency Act and the Clean Air Act and its amendments.

TRANSIMS is a set of integrated analytical and simulation models and supporting data bases whose development is led by the Los Alamos National Laboratory. The TRANSIMS methods deal with individual behavioral units and proceed through several steps to estimate travel. TRANSIMS predicts trips for individual households, residents and vehicles rather than for zonal aggregations of households. TRANSIMS also predicts the movement of individual loads of freight. A regional microsimulation executes the generated trips on the transportation network to predict the performance of individual vehicles and the transportation system. Motor vehicle emissions are estimated using traffic information produced by TRANSIMS. A major advantage of TRANSIMS for air quality analysis is the detail it provides regarding motor vehicle operation.

Our approach is to develop an interim operational capability (IOC) for each major TRANSIMS component. When the IOC is ready, we will complete a specific case study to confirm the IOC features, applicability, and readiness. We will complete the specific case study with the collaboration of a selected MPO staff. This approach should provide timely interaction and feedback from the TRANSIMS user community and more interim products, capabilities, and applications.

The Traffic Microsimulation will be the first IOC, with the goal of having it ready for testing near the end of calendar year 1995. As this IOC is developed, we will work with the selected MPO, North Central Texas Council of Governments (NCTCOG) (Dallas-Fort Worth), to identify studies that the IOC should support.

TRANSIMS ARCHITECTURE

Before we began development specific to the Traffic Microsimulation Interim Operational Capability (IOC), we established the overall TRANSIMS software framework and architecture. This comprehensive planning and design effort has required time and effort, but should result in a flexible, robust structure for research and development of future TRANSIMS capabilities. The methods for the later IOCs should be implemented more quickly within this architecture without significant design changes. To provide computational speed and an operational capability available to end users in the near term, we are developing the first IOC to be distributed for parallel computation on a network of SUN workstations.

We established an architecture design team to develop the architectural framework for the TRANSIMS software. The architecture goal was to ensure that the various TRANSIMS components are integrated effectively, for the first IOC, future IOCs, and the final TRANSIMS software. The architecture is designed so that TRANSIMS is flexible, expandable, portable, and maintainable throughout its lifetime.

The resulting framework, shown in Figure 1, is a layered architecture with the following layers:

Application: The Analyst Toolbox, which provides a centralized interface between the user and TRANSIMS.

System: Interim Household and Commercial Activity Disaggregation, Interim Intermodal Route Planner, Low Fidelity

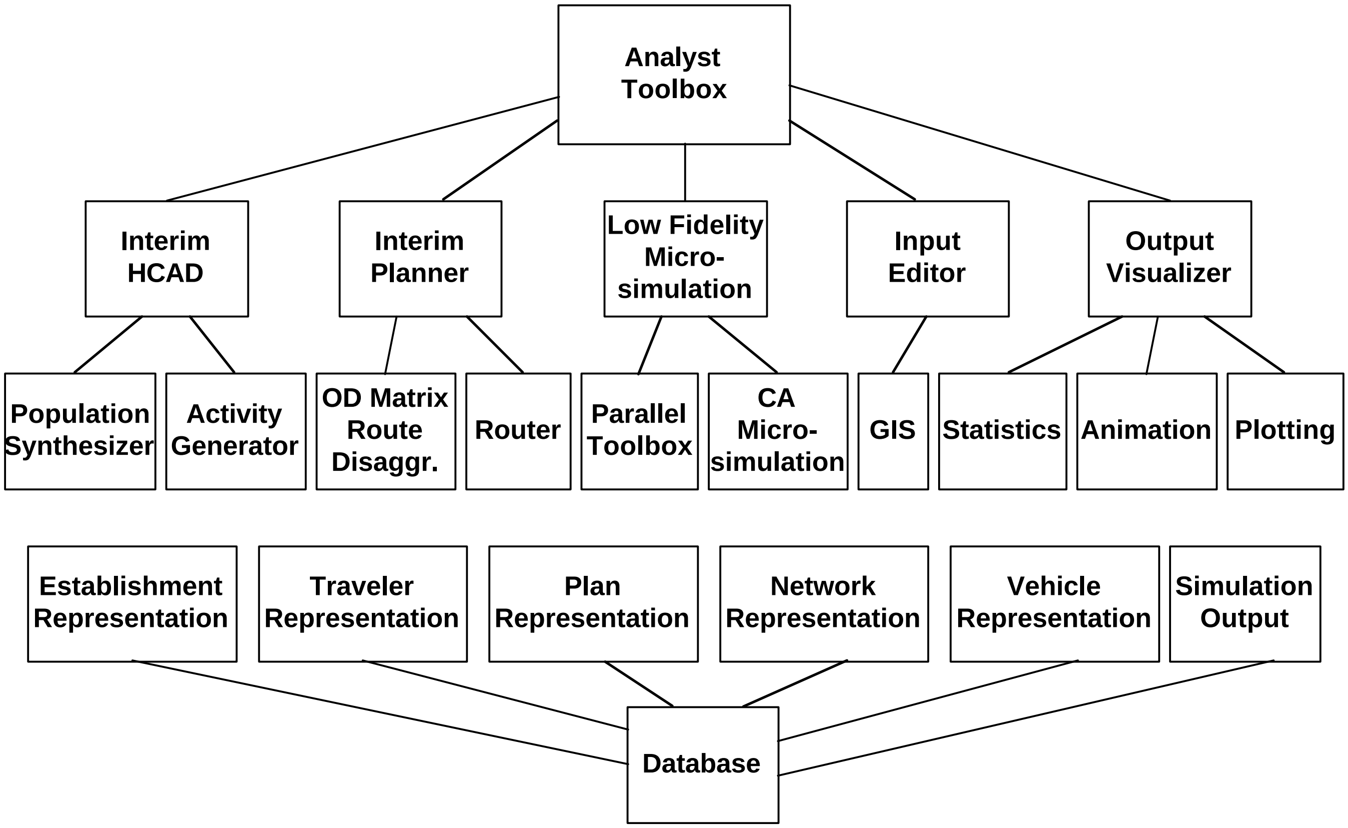

Figure 1. TRANSIMS Software Architecture for
the Traffic Microsimulation Interim Operational Capability

Microsimulation, Input Editor, and Output Visualizer centralize access to the major functional components of TRANSIMS. Additional systems will be added for future IOCs and the end product.

Subsystem (High-Level): Ten subsystems have been identified that provide services to one or more of the TRANSIMS systems. The subsystems enhance the reusability and flexibility of the software.

Subsystem (Low-Level): Six representational subsystems provide basic services (data and operations on data) to the high-level subsystems. They provide a common representation of objects such as vehicles, travelers, the transportation network, etc.

Subsystem (Utility): The utility subsystems provide basic domain-independent services to the higher level components of TRANSIMS. They isolate the domain subsystems from dependence on operating systems, file systems, etc.

The architectural design team prepared recommendations for the software and hardware development environment for TRANSIMS. We selected several commercial products to leverage our development activities. We established the software engineering process to be followed, including coding and documentation standards, configuration management, iterative object-oriented development, and procedures for review and testing. After the formal review and acceptance of the recommendations, we started implementing the recommendations by purchasing required software and hardware, establishing configuration management procedures, and instituting a software review process.

We initiated subsystem design of the TRANSIMS architecture by formation of design teams. The database subsystem team designed the database subsystem, a unified means of organizing, storing, and retrieving TRANSIMS data. Design teams have developed designs for the network representation, the traveler representation, establishment representation, plan representation, and vehicle representation. For example, the network representation subsystem provides a common representation of traffic networks and subnetworks consisting of nodes, links, lanes, and traffic control objects such as unsignalized controls and timed and actuated signals. Allowed movements, turn protections, and interfering lanes during turns can be computed from information in the basic network representation.

The Parallel Toolbox subsystem, developed initially by the TRANSIMS research team, distributes the microsimulation on a local area network of workstations for IOC-1. The research and microsimulation team members have been augmenting the Parallel Toolbox to interface the microsimulation with the network representation adopted for TRANSIMS.

TRIP PLANS FOR IOC-1

The first IOC traffic microsimulation will require trip plans (origins, destinations, departure times, routes, etc.) for the individual travelers. Because we are in the process of developing the methods to translate activity demand into transportation demand, the initial modules for the Household and Commercial Activity Demand and the Intermodal Route Planner will rely on existing data and extensions to current methods. These interim modules, their interfaces, and data flow will require few or no changes when the activity demand models become available. They also might serve a useful purpose for certain classes of analyses even after the activity-based methods become available for TRANSIMS. Techniques for creating baseline synthetic populations are described briefly in the next section.

The interim modules will take information regarding trip purposes within current origin-destination matrices or production-attraction tables and will assign up to three activities to each traveler. Additional information will identify activity destinations and generate simple travel goals and preferences. This interim planner will use simple cost functions, such as time or distance minimization, within the Likely Path algorithm to find the travelers' routes on current or expanded roadway networks. A trip plan incorporating origin; departure time; node, link, and expected arrival time sequence; and destination will be the output from the planner. For analyses within subregions of the metropolitan region, the plans will be truncated to apply only to the subregion.

BASELINE SYNTHETIC POPULATIONS

We have developed a procedure for creating a baseline synthetic population of households. The individuals in the households are used as travelers in the activity-based TRANSIMS model. This population is created from 1990 census data and is aged to the desired date. At this time we consider only the creation of the baseline population without "aging." These methods are described more completely in the document, "Creating Baseline Synthetic Populations," by Richard J. Beckman, Keith A. Baggerly, and Michael D. McKay.

The 1990 census data used to develop the baseline population includes the Census Standard Tape File 3 (STF-3) and the Public Use Microdata Sample (PUMS). We create distinct households for each census tract or block group area (we currently use census tracts). The procedure involves four stages. First, for the census tract in question, we group the census summary tables from STF-3 and the corresponding PUMS sample by family and non-family households. Second, for each households type, we construct a multiway table of the demographics available from STF-3. Third, we create households by random selection (according to the probabilities in the constructed multiway table) of similar households in the PUMS sample. The last stage consists of aging the population to the desired date.

The demographic summary tables in STF-3 for family households are (1) race of householder by household class (a combination of household type and presence and age of children), (2) age of householder, (3) family income, and (4) the number of workers in the family. We use these four summary tables and the corresponding sample from the PUMS to create the five-dimensional multiway table of probabilities for each combination of the five demographic variables. We use iterative proportional fitting to generate the multiway tables. It is easy to implement and it converges in a few iterations.

SYNTHETIC POPULATION VALIDATION

We examined methods to validate and verify these household construction procedures. STF-3 contains a summary table for the total number of persons in family households. Because the total number of people is not controlled in the construction of family households, this summary can be used as one validation of the resulting population. We generated populations of households for census tract 1.07 of Bernalillo County NM. The resulting distribution of persons per household compares favorably with the "true" distribution given in STF-3A for that census tract.

For validation and verification of household characteristics not in STF-3 (for example, the number of vehicles by the number of people in the households), we can construct a synthetic collection of "census tracts" and corresponding synthetic "PUMS" samples. This relatively simple construction is accomplished by considering PUMS samples as complete "census tracts" and combining approximately 20 neighboring PUMS samples. The resulting population of approximately 100,000 people then is sampled to create the synthetic "PUMS" for the constructed "census tracts."

We created synthetic "PUMS" samples by combining 22 PUMS from the San Francisco Bay area. Using the 22 PUMS as complete "census tracts", we used the household generation procedure to create synthetic family household populations. The joint distribution of persons by household by the number of vehicles compared favorably with that known from the 22 PUMS. The resulting distributions fit the truth very well except for four City-of-San-Francisco PUMS where we overestimated the number of vehicles in households with few people. This is not unexpected because parking problems and a good mass transit system make owning multiple vehicles undesirable in the City. Hence, the correlation structure in the individual PUMS taken as "census tracts" differs from "census tract" to "census tract." In actual applications of the method on real census tracts or block groups, the census tracts in a PUMS will be more homogeneous than the PUMS used as "census tracts" to create validation PUMS in the Bay Area validation set. Thus, this procedure will be better when applied to real census tracts than the already good results shown in the validation.

ENVIRONMENTAL MODELING

We have extended the meteorological model to treat situations where clouds are important. In a coastal environment, such as Portland, Oregon, low-level clouds from the ocean influence the wind and dispersion characteristics. Earlier versions of HOTMAC (High Order Turbulence Model and Analysis Code) formed clouds, but it didn't treat the effect clouds have on radiation. To extend the model to treat clouds properly, we have revised our radiation transfer routines to describe the effects clouds have on heating and cooling in the atmosphere and on preventing sunlight from reaching the ground. We incorporated a subroutine that had been used in a one-dimensional version of HOTMAC and modified it to treat radiation transfer through clouds to the surface of the ground. The improved model produces plausible results and runs reliably, but requires further testing.

We have compiled the evaporative emissions code EVAP 3.0 and run it in a stand-alone mode. We have determined an interface between the trip planner and the EVAP code. The EVAP code uses a time-off and a time-on matrix and we can use the planner to generate these two matrices for each cell in the air chemistry model. This will give an aggregate evaporative emissions compatible with MOBILE5. We could disaggregate by constructing the matrix for each vehicle type and then doing the calculation for each vehicle type. This would require more data on individual vehicle characteristics.

We have received Sierra Research's VEHSIME code, which we will use for the initial emissions capability within TRANSIMS. We have begun examining VEHSIME to understand how to interface its models with the vehicle output from TRANSIMS.

FURTHER INFORMATION

For further information about the TRANSIMS program, please contact:

Dr. LaRon L. Smith
Los Alamos National Laboratory
Mail Stop F606
PO Box 1663
Los Alamos, New Mexico 87545

Phone: 505-665-1286
Fax: 505-665-5204
E-mail: llsmith@lanl.gov